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ABSTRACT

This chapter describes various programs providing secondary mathematics curricula to migrant students and discusses some challenges of integrating the cultural and linguistic experiences of migrant students learning mathematics. Among the distance-education programs designed for migrant students, the University of Texas Migrant Program delivers 22 core courses required for high school graduation in Texas, including Algebra Across the Wire, which has had a high rate of success with migrant students. Project SMART, a collaborative distance-learning program between Texas and its receiving states, has offered pre-algebra, algebra, geometry, and other mathematics courses to migrant students using interactive or delayed television instruction and videotaped lessons. The ESTRELLA program serves secondary migrant students who travel from six targeted Texas school districts to Illinois, Minnesota, Montana, or New York. Program elements include a Web site, e-mail, multimedia instruction, self-paced lessons, and cybermentors. The Portable Assisted Study Sequence (PASS) allows students to work semi-independently at their own pace, completing courses one unit at a time and accruing credits toward graduation. Although these programs offer alternative delivery approaches, instructors are still challenged to make connections between mathematics instruction and students' culture and language. A recent study of students' think-aloud protocols while solving word problems demonstrated the confusion arising both from limited English proficiency and from the use of mathematical language in non-mathematical contexts. Ways to increase the cultural relevance of mathematics instruction are also discussed. (SV)

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CHAPTER 14

Alternative Secondary Mathematics Programs for Migrant Students: Cultural and Linguistic Considerations

BY SYLVIA CELEDÓN-PATTICHIS

The manual *Principles and Standards for School Mathematics* includes equity as one of its principles: "Excellence in mathematics education requires equity—*high expectations* and *strong support* for all students."[1] Migrant students need strong support from educators while traveling from state to state or within a state. These students worry about fitting in culturally and linguistically, performing in content areas such as mathematics, and meeting their families' needs.[2]

One of the goals of the U.S. Department of Education Migrant Education Program (MEP) is "to ensure that migrant children have access to services to assist in overcoming cultural and language barriers, health-related problems, and other challenges that place

[1]National Council of Teachers of Mathematics, *Principles and Standards for School Mathematics* (Reston, VA: National Council of Teachers of Mathematics, 2000), 11.

[2]Yolanda G. Martinez and Ann Cranston-Gingras, "Migrant Farm Worker Students and the Educational Process: Barriers to High School Completion," *High School Journal* 80 (1996): 28-37. Emphasis added.

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children at risk for completing their education."[3] Similarly, the National Council of Teachers of Mathematics (NCTM) recognizes the importance of mathematics teaching and learning for culturally and linguistically diverse students. In a position statement on mathematics for language-minority students and English-as-a-second-language (ESL) learners, NCTM proposed the following:

- All students, regardless of their language or cultural background, must study a core curriculum in mathematics based on the NCTM Standards.
- Educators must identify and remove language-based barriers by providing first- and second-language support while learning mathematics.
- Counselors and teachers must support and encourage students to enroll in higher-level mathematics and continue their higher education in technical fields.
- The importance of mathematics and the nature of the mathematics program must be communicated both to students and parents.
- The mathematics curriculum, teaching, and assessment must include connections to the cultural heritage of students and build on prior knowledge and experiences.[4]

Schools must prepare migrant students for higher education, which includes offering alternative mathematics curricula that enable them to complete their high school diplomas.

The first part of this chapter analyzes secondary mathematics curricula available to migrant students nationwide through distance-learning programs, including the University of Texas Migrant Student Program, Project Summer Migrants Access Resources through Technology (SMART), and Encouraging Students through Technology to Reach Expectations in Learning Life Skills and Achievement

[3]U.S. Department of Education, Office of Migrant Education, *Migrant Education Program* (Washington, DC: U.S. Department of Education, 13 November 1998), http://www.ed.gov/offices/OESE/MEP/ (accessed October 2, 2002), 2.

[4]National Council of Teachers of Mathematics, *Mathematics for Second-Language Learners* (Reston, VA: National Council of Teachers of Mathematics, July 1998), http://www.nctm.org/about/position_statements/position_statement_06.htm/ (accessed October 2, 2002).

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(ESTRELLA). Also described is the Portable Assisted Study Sequence (PASS) Program, provided by the BOCES Geneseo Migrant Center, which is not a distance-learning program but does offer a consistent curriculum for migrant students. These programs focus particularly on the secondary level, where higher level mathematics, a requirement for acceptance to most four-year universities, often has been inaccessible to migrant students (see Table 1). The second part of the chapter examines the challenges of integrating the cultural and linguistic experiences of migrant students into

Table 1: Distance-Education Programs in Mathematics

Name of Program and Course Offerings	Contact Information
1. **University of Texas Migrant Student Program** Algebra 1A* & 1B, Algebra Across the Wire, Geometry A & B	Peggy Wimberley Phone: 800-444-1905 or 512-471-0581 Fax: 512-232-5533 E-mail: peggywimberley@mail.utexas.edu http://www.utexas.edu/cee/dec/migrant/courses.html
2. **Project SMART** TAAS Math Preparation (noncredit), Algebra 1A*, Geometry A & B	Patricia Meyertholen Phone: 512-463-9067 Fax: 512-463-9759 http://www.jump.net/~newman/tea/toc97.html
3. **Project ESTRELLA** Course offerings through NOVA Net and use of laptops	Brenda Pessin, Project Director Phone: 312-663-1522, ext. 233 E-mail: brenda_pessin@msn.com http://www.estrella.org
4. **Portable Assisted Study Sequence (PASS)** General Math A & B, Consumer Math, Consumer Economics, Basic Algebra/Calculator, Algebra A & B	Robert Lynch, Director Phone: 800-245-5681 Fax: 716-658-7969 E-mail: pass@migrant.net http://www.migrant.net/pass/

*A = First Semester

B = Second Semester

learning mathematics. The final section summarizes how schools can better address the needs of migrants studying mathematics.

Alternative Approaches to Mathematics Curricula

Distance education can provide migrants with continuity in secondary mathematics education. Most of the programs described in this chapter initially were implemented for migrant students only but now have become schoolwide programs that help any student who needs to make up missed work.[5]

The University of Texas Migrant Student Program

Since 1987, The University of Texas at Austin has provided a program that offers 22 of the core courses required for high school graduation in Texas, delivered in a distance-education format designed specifically to meet the needs of migrant students. More than 75 percent of the students in the program complete their courses. The program is based on research that identifies best teaching strategies for migrant students. For example, characteristics of effective distance-learning courses include the following:

- short study units and vocabulary reviews to ensure comprehension of content and to improve language and vocabulary skills
- commentary that explains and demonstrates subject matter in clear, concise language
- appropriate, effective visual presentations that reinforce course elements
- various objective activities that give students ample opportunities to apply and practice new knowledge and skills
- writing exercises that invite students to relate subject matter to their own lives[6]

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[5]Martinez and Cranston-Gingras, "Migrant Farm Worker Students"; and *Improving America's Schools Act of 1994*, Public Law 103-382, §§ 1301-09 (1994).

[6]Judy Ashcroft Copeland and Thomas M. Hatfield, "Migrant Student Program," *Discovery* 15, no. 4 (2000): 31, http://www.utexas.edu/admin/opa/discovery/disc2000v15n4/disc_migrant.html/ (accessed October 2, 2002).

The program delivers courses in nontraditional ways to accommodate migrant students' needs. For example, students can earn credit through correspondence or by exam. It also employs on-site grading, audio-conferencing, CD-ROMs, and the Internet. These delivery formats provide students the option of doing coursework at home, at school through extended-day programs offered before and after school, or in summer school programs. This flexibility is important to migrant students as they move from place to place. Furthermore, a network enables Texas and out-of-state migrant educators to interact personally with students enrolled in distance-education courses.

One of the courses offered through the program is Algebra Across the Wire, which allows students around Texas and in other states to earn missed credits via live audio-conferencing. The technology is similar to a telephone conference call, as one instructor can communicate with students throughout Texas and in 50 schools outside the state.

The first semester of algebra was first taught during the summer of 1992 to a group of high school migrant students at Texas A&M at Kingsville, Texas. The student population consisted of 13 students from South Texas—8 males and 5 females aged 15 to 18. Most of the students had taken algebra two or more times, and their scores on the Stanford Diagnostic Mathematics Test indicated low achievement in problem solving, mathematical concepts, and computation. In spite of this previous lack of success, the final grade average for the first Algebra Across the Wire class was 88 percent, with all students passing the course.[7]

Although the instructor taught via audio-conferencing, an on-site instructor was available an hour before the course began to answer students' questions. In addition, students who wanted additional review or who experienced difficulty with the course had access to an instructional videotape.

Algebra Across the Wire was offered to 36 migrant students in Greeley, Colorado, and in Laredo, McAllen, and El Paso, Texas, during

[7]Kathy J. Schmidt, Michael J. Sullivan, and Darcy Walsh Hardy, "Teaching Migrant Students Algebra by Audioconference," *The American Journal of Distance Education* 8, no. 3 (1994): 51-63.

the summer of 1993; 33 students passed the course, 2 dropped, and 1 failed. The unsuccessful student was an English language learner who was unable to work effectively with a translator during class time. The overall final grade average for the four sections of the course was 92 percent.[8]

Given this high success rate, the number of students enrolled in Algebra Across the Wire almost doubled, and the number of sites increased to five in the summer of 1994. Two sites offered a second semester of algebra in addition to the first. The overall final grade average was 90 percent for the 58 students who completed the course.

Project SMART

Project SMART, a collaborative distance-learning program between the Division of Migrant Education of the Texas Education Agency and its receiving states, aims to increase educational opportunities for migrant students. Combining technology and innovative instructional design, Project SMART includes several delivery models—live interactive televised instruction, live noninteractive televised instruction, delayed televised instruction, and videotaped lessons. Mathematics courses that have been videotaped in the past include Mathematics of Money, Pre-Algebra A and B, Informal Geometry A, and Algebra A and B.

Project SMART addresses the needs of two groups of students. First, migrant students who remain in Texas during the summer can receive instruction in their homes, at school sites, or in community centers via televised classes. A locally employed teacher or paraprofessional visits students' homes to offer assistance. Second, students who live temporarily outside Texas can participate if they are enrolled in an established summer education program for migrant students. Again, televised classes are the main conduit of instruction. In out-of-state programs, SMART partners are responsible for monitoring student progress, assessing student achievement, implementing additional instruction during nonbroadcast times, and sharing ideas with the television teacher via a toll-free telephone number. SMART part-

[8]Ibid.

ners play a critical role by interacting with the students face to face and providing follow-up activities to the televised instruction.[9]

ESTRELLA

Funded by the Office of Migrant Education (OME), ESTRELLA provides migrant students in Texas with opportunities to earn credits toward graduation, prepare for exit-level standards-based achievement testing, and/or enhance their academic skills. Participation in the program is not automatic; students must meet certain criteria. First, to participate in ESTRELLA, migrant students must show a pattern of moving from Texas to Illinois, Minnesota, Montana, or New York. Priority enrollment is extended to motivated juniors and seniors who have strong parental support; freshmen and sophomores are given second priority. Other selection criteria include having a phone, needing credits, having study skills and computer literacy, and being a self-advocate. Migrant students are identified from six targeted Texas school districts: Eagle Pass, La Joya, Mercedes, Pharr-San Juan-Alamo, San Felipe-Del Rio, and Weslaco.

Key components of ESTRELLA include collaboration, distance learning, cyber mentors, and visual learning. At the center of the program is the collaborative effort between the receiving states and the home-base state of Texas. The ESTRELLA Working Web Home Page is a place for learning, where instructors and students can share ideas and information. Furthermore, teachers, family, and friends communicate with one another via e-mail.[10]

ESTRELLA's distance learning is provided through NOVA Net. The interactive curriculum includes graphically rich multimedia lessons, with self-paced courses that adapt to student needs. Students take their courses with the same teacher. This continuity allows them to complete the coursework from their homes or anywhere they travel. Most important, migrant students do not have to worry about differences in curricula from state to state. Cyber mentors are an important facet of the program. In addition to assisting with coursework, cyber

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[9]Meta Associates, *Project SMART Linking Classrooms Through Distance Learning in Montana* (N.p.: [Meta Associates], n.d), http://www.metaassociates.com/MT_Smart_right.html/ (accessed October 2, 2002).

[10]ESTRELLA Web Site, http://www.estrella.org/ (accessed October 2, 2002).

mentors are positive role models who help migrant students make the transition from high school to postsecondary education and who inform them of career options.

Portable Assisted Study Sequence (PASS)—BOCES Geneseo Migrant Center

Recognized nationally and used by 29 states, PASS originated in 1978 as part of California's Secondary Migrant Dropout Prevention Program. PASS offers mobile secondary students an alternative means to earn full or partial credits toward graduation. In addition, Mini-PASS serves middle-school students and offers similar educational opportunities. Both programs are designed to meet the needs of migrant, alternative, and nontraditional students. Data from 1991 to 1996 indicate that PASS serves an average of 11,870 students and graduates an average of 2,186 students per year.

Each semester course consists of five units with unit tests. PASS provides students with all materials needed, such as rulers, graph paper, textbooks, and reference materials. What makes PASS alternative is its flexibility to allow students to work semi-independently with the assistance of a mentor, who meets with the students on a regular basis. The students can complete a course at their own pace and, with the assistance of more than one mentor, begin a course in one city and complete it in another. The curriculum does not change, so students can finish the work on two units in one location and another three units at a different place. When students pass the five unit tests, they earn a half credit toward graduation.

PASS offers a variety of courses in language arts, science, mathematics, and other subjects. The mathematics courses include General Math A & B, Consumer Math, Consumer Economics, Basic Algebra/Calculator, and Algebra A & B. The 2000-2001 National PASS Report data indicate that mathematics and science are the subjects least enrolled. Although the course offerings may help students meet minimum mathematics requirements for a high school diploma, educators should be careful not to limit students' options to regular graduation tracks, versus college preparatory tracks. All migrant students should be encouraged to take courses beyond algebra and geometry, which increase their chances to enroll in a four-year university and eventually find a job involving higher level mathematics.

The course completion rate was 31.1 percent in 1991-1992 (12,283 courses enrolled, 3,823 courses completed), 44.7 percent in 1992-1993 (13,541 courses enrolled, 6,063 courses completed), and 68.7 percent in 1995-1996 (11,742 courses enrolled, 8,068 courses completed). Although PASS had low success rates in the early 1990s, the course completion rate increased substantially in the mid-1990s. Students' essays portray success stories from PASS and indicate that the program has made a significant difference in helping students finish high school.[11]

Cultural and Linguistic Influences in Mathematics Learning

All of these programs create alternative approaches that address the needs of migrant students. A challenge still remains to make the curriculum relevant to students' linguistic and cultural experiences. Making connections between migrant students' experiences and mathematics is left up to the instructors and on-site educators. Despite the success rates of these programs, it is important to consider the challenges migrant students encounter as they try to study various subjects while learning a second language.

Learning a Second Language

Migrant ESL students face the dual tasks of learning new linguistic structures and academic content. The process of learning a new linguistic system and academic content does not occur automatically. In fact, to attain the same academic performance as native English speakers, English language learners may take five to seven years or more to develop proficiency in a second language. Jim Cummins (1992) distinguishes between two levels of language proficiency—basic interpersonal communication skills (BICS) (i.e., social language) and cognitive/academic language proficiency (CALP), the type of language required to understand mathematics content. If students have not developed the language used for academic tasks in their first

[11]National PASS Center Web Site, http://www.migrant.net/pass/ (accessed October 2, 2002); National PASS Center, *Portable Assisted Study Sequence: 1995-1996 National Report* (Mt. Morris, NY: Geneseo Migrant Center, 1997); and *PASS: 2000-2001 National Report* (Mt. Morris, NY: Geneseo Migrant Center, 2002), http://www.migrant.net/pass/pdf/2002.pdf/ (accessed August 1, 2003).

language, they may experience difficulty with CALP in their second language.[12]

This potential dilemma has two implications. First, if migrant students have CALP for mathematics in their first language, mathematical concepts (e.g., addition, subtraction, division, multiplication) will transfer to their second language, with changes in the lexical items (vocabulary) attached to these concepts. Second, if migrant students do not have CALP in their first language, they will have considerable difficulty developing CALP in their second language. Teachers and migrant students may need to use the first language more frequently when referring to mathematical terms in problem solving.[13]

Mathematics word problems will be significantly complex for two reasons. First, processing linguistic structures from one language to another takes time; some words may not make sense to the reader. Second, mathematics word problems are not always straightforward in comparison to problems that involve simple calculations. As a result, ESL students easily can misinterpret text or be confused by word problems with more than one solution.[14]

Migrant students need mathematical activities that address language in natural as well as mathematical contexts. Initial reading of word problems should focus on understanding so students learn to differentiate between natural language and mathematical language.

In a recent study, I conducted think-aloud protocols with nine ESL students of Mexican descent in a self-contained 6th to 8th-grade classroom. They struggled to construct meaning from word problems when the mathematical language was mixed with natural everyday

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[12]Virginia P. Collier, "Acquiring a Second Language for School," *Directions in Language & Education* 1, no. 4 (fall 1995), http://www.ncela.gwu.edu/ncbepubs/directions/04.htm/ (accessed October 2, 2002); and Jim Cummins, "Language Proficiency, Bilingualism, and Academic Achievement," in *The Multicultural Classroom: Readings for Content-Area Teachers*, ed. Patricia A. Richard-Amato and Marguerite A. Snow (White Plains, NY: Longman, 1992), 16-38.

[13]Cummins, "Language Proficiency."

[14]David Pimm, *Speaking Mathematically: Communication in Mathematics Classrooms* (New York: Routledge & Kegan Paul, 1987); and Pilar Ron, "Spanish-English Language Issues in the Mathematics Classroom," in *Changing the Faces of Mathematics Series, Perspectives on Latinos*, ed. Luis Ortiz-Franco, Norma G. Hernandez, and Yolanda De La Cruz (Reston, VA: National Council of Teachers of Mathematics, 1999), 23-33.

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language. For example, only one of the nine students could solve the following problem:

> *A number 300 can holds 13 7/8 ounces. A number 2 can holds 28 ounces. How many more ounces does a number 2 can hold than a number 300 can?*[15]

Most of the students wanted to solve the problem using 300 and 2, which are only labels for the cans. Furthermore, the students interpreted *can* as an auxiliary verb not as a noun needed to solve the problem. Words with multiple functions (e.g., the word *can* as a noun and as an auxiliary verb) may confuse migrant students who are beginning to learn English. In addition, students performed poorly on this problem regardless of whether English or Spanish was used, a finding that indicates confusion also stemmed from the use of mathematical language in nonmathematical contexts.[16]

Mathematics educators are often unaware of the role of language acquisition in the teaching and learning of mathematics for migrant students. It is critical that mathematics educators consult bilingual educators when designing distance-education courses, especially those offered through audio conference, where context-embedded instruction may be compromised by the lack of visual cues that support verbal language for English language learners. A resource teacher needs to be present where these courses are offered to provide migrant ESL students with instant feedback, cues, and clues.[17]

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[15]Robert E. Eicholz and others, *Addison-Wesley Mathematics: Grade 6* (Menlo Park, CA: Addison-Wesley, 1991).

[16]Sylvia Celedón-Pattichis, "Constructing Meaning: Think-Aloud Protocols of ELLs on English and Spanish Word Problems," *Educators for Urban Minorities* 2, no. 2 (2003): 74-90.

[17]Jim Cummins, "Wanted: A Theoretical Framework for Relating Language Proficiency to Academic Achievement among Bilingual Students," in *Language Proficiency and Academic Achievement*, ed. Charlene Rivera (Clevedon, England: Multilingual Matters, 1984); for studies on the role of language in algebra, see Jose P. Mestre, "The Role of Language Comprehension in Mathematics and Problem Solving," in *Linguistic and Cultural Influences on Learning Mathematics*, ed. Rodney R. Cocking and Jose P. Mestre (Hillsdale, NJ: Lawrence Erlbaum, 1988), 201-20

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Cultural Influences on Mathematics Learning

School mathematics experiences for students in the United States often have been treated separately from the students' lives outside school. Students' voices rarely are included in the common mathematics-driven curriculum. Although the NCTM's standards movement has had a major impact in the professional, political, and public realms, students' learning experiences are still detached largely from their personal experiences.[18]

Migrant students have "funds of knowledge" within their families, but mathematics educators may be unaware of them because of sociocultural and socioeconomic differences.[19] Migrant students should have opportunities to write their own word problems and share their personal experiences through journal writing and other interactive/experiential methods. Educators should try to determine which linguistic structures are best understood (or not understood) in word problems. I gave the nine ESL students the following word problem:

> *Admission to Hall's planetarium costs $4.50 for adults and $2.75 for students. Mr. Emery took his class of 27 students to a show. How much did Mr. Emery and his class spend for tickets?*[20]

None of the nine knew what "Hall's planetarium" meant. These findings are consistent with a study by Walter Secada, who found that elementary Hispanic bilingual students encountered difficulties with word problems when their personal experiences did not match the linguistic expressions presented in the word problems. Thus, it is critical to include migrant students' experiences in every aspect of the curriculum.[21]

Mathematics educators can make connections by combining mi-

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[18]National Council of Teachers of Mathematics, *Principles and Standards*.

[19]Luis C. Moll, "Literacy Research in Community and Classrooms: A Sociocultural Approach," in *Theoretical Models and Processes of Reading*, 4th ed., eds. Robert B. Ruddell, Martha R. Ruddell, and Harry Singer (Newark, DE: International Reading Association, 1994), 469-82.

[20]Eicholz and others, *Addison-Wesley Mathematics*.

[21]Celedón-Pattichis, "Constructing Meaning"; and Walter G. Secada, "Degree of Bilingualism and Arithmetic Problem Solving in Hispanic First Graders," *Elementary School Journal* 92, no. 2 (November 1991): 213-31.

grant students' experiences outside the classroom with mathematical concepts, such as distance = rate x time. Migrant students, particularly those in middle or high school, often take the initiative to plan activities with their parents. One activity could involve planning an actual trip, justifying the best route of travel from one city to another, and determining how long the trip would take based on a specific speed limit and distance. Another activity could include creating a budget for the trip and later comparing the original calculations with the actual money spent. The concepts covered in these activities could range from using decimals, fractions, and percentages to performing statistical analyses on the two budget plans. The activities involve problem solving using experiences outside the classroom.[11]

Conclusion and Discussion

This chapter has reviewed alternative secondary programs that provide flexibility in helping migrant students complete credits in their mathematics education. Specifically, The University of Texas Migrant Student Program, Project SMART, ESTRELLA, and the Portable Assisted Study Sequence deliver secondary courses in mathematics throughout the country. Each of these programs emphasizes linguistic and cultural influences in teaching mathematics. Research is needed to explore the experiences of migrant ESL students enrolled in mathematics distance-education courses. Educators should ensure that migrant ESL students are not excluded from these programs. Instead, migrant students should be provided the necessary support, such as the help of bilingual educators knowledgeable about mathematics, to succeed in distance-education and/or other alternative curricula.

Think-aloud protocols can benefit mathematics educators who teach migrant ESL students enrolled in distance-education programs. Students should be encouraged to express their thoughts about the vocabulary used in different word problems to find out what words help or hinder their understandings. This approach also monitors ESL

[11]For a specific activity integrating the experiences of migrant students into elementary mathematics, see Frederick L. Silverman and others, "On the Road with Cholo, Vato, and Pano," *Teaching Children Mathematics* 17, no. 6 (February 2001): 330-33.

students' conceptual and procedural knowledge. In some instances, there may be a mismatch between what students conceptualize and what they say or do. It is not uncommon to hear ESL students say they will add, when, in reality, they want to multiply. The problem could be that ESL students do not know the correct vocabulary for different mathematical operations in English (e.g., addition, subtraction, division, and multiplication) while understanding the concepts represented by the symbols (e.g., +, —, ÷, and x).

Finally, teachers need to draw on students' linguistic and cultural experiences to make mathematical connections between everyday use of English and language specific to mathematics. Mathematics educators need to seek help from bilingual/ESL specialists when preparing distance-education courses. Combining the knowledge of mathematics and bilingual/ESL educators can help migrant students make better connections between their lives and the classroom.

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